Inorganic Elemental Biosignatures: Does Metabolism Affect Trace metal Composition of *Calothrix* Filaments

Microorganisms, especially bacteria, are known to be very effective "scavengers" of metal ions from dilute solution from both aqueous environments and rock, which often serves as a substratum for growth of epi- or endolithic microbial communities. The existence of such communities is widespread today and can be traced back in the geological record to the Archaean Epoch (> 3 billion years ago). It is conceivable that, as today in modern environments, the microbial communities of the past were able to lay down unique inorganic elemental signatures as a record of their presence. The present study represents the beginning of a long term study in which we aim to elucidate the inorganic "footprints" left behind in the rock record by microbial life. Our ultimate goal is to determine whether, long after recognisable biological structural features have disappeared, there is a distinct pattern of trace metals left. Our overall study plan has two thrusts: (1) to characterise the elemental composition of common crustal lithofacies (see abstract by Conrad et al.) and, (2) for the present study, to address the aforementioned microbial trace element signature. We have used both energy dispersive x-ray spectroscopy (EDS) in an environmental scanning electron microscope (ESEM), and XPEEMS (x-ray photoelectron emission microscopy), a much higher resolution, narrower range technique connected to a unique instrument known as MEPHISTO, which requires synchrotron x-ray energy as its source. ESEM allows analysis and imaging of fully hydrated (live) specimens so that any elemental analysis can be performed on chemically unaltered specimens.Our test specimen for the present study was *Calothrix*, a sheathed, filamentous cyanobacterium. The filaments exhibit meristematic growth so that each one has a metabolically active "head" and a much narrower, inactive "tail" which terminates in empty sheath material. Our analyses show that the living (sheath plus metabolising cell) organism has a different trace element signature than the "dead" (sheath only) structural fraction. These preliminary results suggest that our approach of using ESEM-EDS as an initial survey of inorganic chemical composition and then analysis of specific elements by MEPHISTO is suitable as a primary step in investigations of the trace metal composition of natural samples. In addition, the knowledge that living organic matter has a different trace element signature than dead material has important implications for the interpretation of the dynamic interaction of living microbial communities with the lithosphere and the nature of the inorganic chemical signature that is preserved in the geological record.

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